

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: **Takami Tomohide** Confirmation No.: **7127**
Serial No.: **10/726,370** Group Art Unit: **1722**
Filing Date: **December 3, 2003** Examiner: **Song, Matthew J.**
For: **NANOFIBER AND METHOD OF MANUFACTURING NANOFIBER**

Mail Stop Appeal Brief -- Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

APPELLANT'S BRIEF PURSUANT TO 37 C.F.R. § 41.37

This brief is being filed in support of Appellant's appeal from the rejections of claims 1-9 mailed August 16, 2006. A Notice of Appeal was timely filed on January 16, 2007.

1. REAL PARTY IN INTEREST

The real party in interest is Visionarts, Inc., a Japanese corporation having its principal office at 5-3-22, Minami Aoyama, Minato-ku, Tokyo, Japan 107-0062.

2. RELATED APPEALS AND INTERFERENCES

No related appeals or interferences are pending. *See* appendix titled RELATED PROCEEDINGS APPENDIX.

3. STATUS OF CLAIMS

Pending	:	Claims 1 to 9
Rejected	:	Claims 1 to 9
Objected to	:	None
Allowed	:	None
Withdrawn	:	None
Appealed	:	Claims 1 to 9.

4. STATUS OF AMENDMENTS

No claim amendments were filed subsequently to Final Rejection.

5. SUMMARY OF CLAIMED SUBJECT MATTER

The claimed invention is generally directed to nanofibers having stem-shaped structures and to methods of manufacturing such nanofibers.

Independent claim 1 is directed to a nanofiber comprising numerous nanowires, the nanofiber comprising silicon which is oriented and bundled in a same direction as the nanowires, and provided with a space between the nanowires, such that the nanofiber has a stem-shaped cross-sectional configuration. *See* specification at page 3, line 27 to page 4, line 2; page 10, lines 7-10.

Independent claim 3 is directed to a nanofiber comprising a plurality of silicon nanowires that are oriented along a single axis, wherein a portion of the nanofiber forms a joint that is aligned with the axis, the joint having a diameter that is less than that of the portion of the nanofiber preceding the joint, and that is less than that of the portion of the nanofiber following the joint. *See* specification at page 3, lines 7-11 & lines 24-26; page 10, lines 26-29.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The issues on appeal are as follows:

- whether claim 3 is unpatentable under 35 U.S.C. § 112, first paragraph, for failing to comply with the written description requirement with respect to the disclosure in the original specification of a nanofiber possessing a joint having a diameter less than that of the portions of the nanofiber preceding and following the joint;
- whether claim 5 is unpatentable under 35 U.S.C. § 112, first paragraph, for failing to comply with the written description requirement with respect to the

disclosure in the original specification of a nanofiber having a diameter that is approximately equivalent to the size of the microcrystal grain from which it is formed;

- whether claims 1-4 and 6-9 are unpatentable as being anticipated under 35 U.S.C. § 102(b) by U.S. Pat. No. 5,858,862 to Westwater et al. (“the Westwater patent”); and,
- whether claims 1-2 are unpatentable as being anticipated under 35 U.S.C. § 102(b) by U.S. Pat. No. 5,381,753 to Okajima et al. (“the Okajima patent”).

7. ARGUMENTS

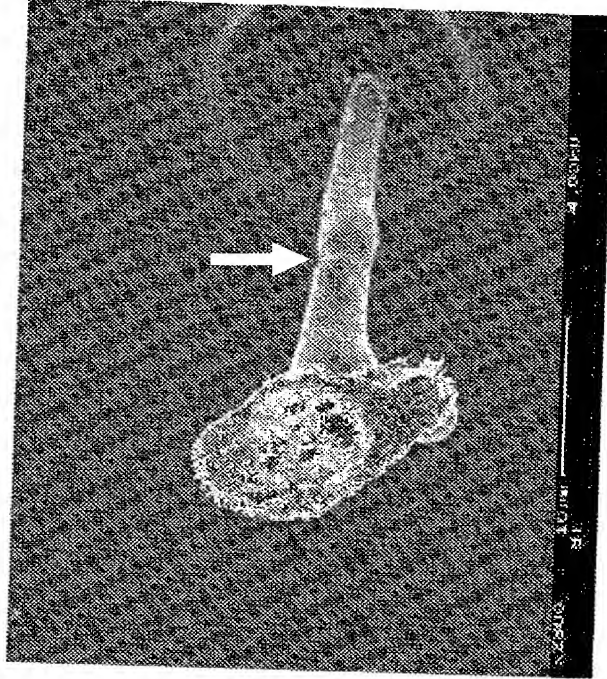
Rejection of Claim 3 Under 35 U.S.C. § 112, First Paragraph

Appellant submits that claim 3 is not invalid under 35 U.S.C. § 112, first paragraph, because the specification as originally filed clearly discloses a nanofiber having a joint portion shaped like a constriction having a diameter less than that of the portion of the nanofiber preceding the joint and less than that of the portion of the nanofiber following the joint. The specification at page 10, lines 26-29 provides that the nanofiber of the present invention may be manufactured such that the diameter of the nanofiber may be configured with a small joint, and refers to Figure 4 in which there is depicted a nanofiber having a joint portion having a diameter that is less than that of the portion of the nanofiber preceding the joint and less than that of the portion of the nanofiber following the joint.

As provided in the specification as originally filed, Figure 4 provides an electron microscopy image of a silicon nanofiber of the current invention that was formed when a heat releasing process is provided after a heating process, and is followed by a subsequent heating process. *See* specification at page 4, line 23; page 10, lines 26-29. The specification clearly describes how the inclusion of a heat releasing process that is interposed between a first heating process and a second heating process causes the diameter of the resulting nanofiber to be configured with small joint. *See* specification at page 10, lines 28-29. Figure 4 as originally filed depicts such a nanofiber with a small joint that clearly has a diameter that is less than that of the portion of the nanofiber preceding the joint and less than that of the portion of the nanofiber following the joint.

For clarification purposes, Figure 4 is reproduced below, and the location of the joint portion is identified using a white arrow:

Fig. 4



Accordingly, the specification as filed, including the figures, demonstrates that the present inventors were in possession of a nanofiber featuring a joint having a diameter less than that of the portion of the nanofiber preceding the joint and less than that of the portion of the nanofiber following the joint. *See Moba, B.V. v. Diamond Automation, Inc.*, 325 F.3d 1306, 1319 (Fed. Cir. 2003) (to satisfy the written description requirement, a patent specification must describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention); *Lockwood v. Am. Airlines Inc.*, 107 F.3d 1565, 1572 (Fed. Cir. 1997) (possession is shown by describing the claimed invention with all of its limitations using such descriptive means as, *inter alia*, words and figures). Appellant respectfully submits that the rejection of claim 3 under 35 U.S.C. § 112, first paragraph, should be withdrawn.

Rejection of Claim 5 Under 35 U.S.C. § 112, First Paragraph

Claim 5 is not invalid under 35 U.S.C. § 112, first paragraph, because the specification as originally filed clearly discloses a nanofiber having a diameter that is

approximately equivalent to the size of the microcrystal grain with which the nanofiber is manufactured.

The Office has contended that “[t]he [microcrystal] grain is approximately the size of the nanowire, not the nanofiber”. See 8/16/2006 Office Action at page 3 (underline added). Such contention is clearly mistaken, however, as the specification specifically describes that, in accordance with the present invention, “it is possible to control the diameter and cross-sectional configuration of the silicon nanofibers that will grow”, using “the size of the silicon microcrystal grain”. See specification at page 6, lines 28-30 (underline added).

The specification further provides that “the size of silicon microcrystal grain 2 and the diameter of silicon nanofiber 4 become nearly equal”. See specification at page 7, lines 1-2 (underline added).

These disclosures clearly convey to those skilled in the art that the present inventor was in possession of the invention of claim 5 at the time of the filing of the instant application. See *Vas-Cath, Inc. v. Mahurkar*, 935 F.2d 1555, 1563-64 (Fed. Cir. 1991). Accordingly, Appellant requests withdrawal of the rejection of claim 5 under 35 U.S.C. § 112, first paragraph.

Rejection of Claims 1-4 and 6-9 Under 35 U.S.C. § 102(b) Over the Westwater Patent

Claims 1 and 2

Claim 1 is not invalid under 35 U.S.C. § 102(b) over the Westwater patent because the cited reference does not disclose a nanofiber having a “stem shaped cross-sectional configuration”. The Westwater patent discloses a process for producing “quantum fine wires”, which, according to the Westwater patent, are the same as silicon nanowires. See Westwater patent at col. 1, lines 6-10. The structures produced by the processes disclosed by the Westwater patent are nanowires, *not* nanofibers.

The Office cites Figures 1C, 3, and 4 of the Westwater patent for the proposition that the cited reference discloses silicon nanowires bundled in the same direction such that there is

provided a nanofiber having a stem shaped cross-sectional configuration. *See* 8/16/2006 Office Action at page 3. However, according to the specification of the Westwater patent, Figures 1C only depicts “silicon quantum fine wires”, *i.e.*, silicon nanowires. *See* col. 2 lines 23-26 & lines 44-46; col. 3, lines 12-16 & lines 54-55. The same is true with regard to Figure 3 (*see* Westwater patent at col. 2, lines 33-35; col. 4, lines 9-17), as well as Figure 4 (*id.* at col. 2, lines 36-38). Furthermore, the Westwater patent does not teach or suggest the bundling of the “silicon quantum fine wires” in order to form a nanofiber, let alone a nanofiber of the subvariety provided by the current application, *i.e.*, a nanofiber having a stem shaped cross-sectional configuration. *See Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236 (Fed. Cir. 1989) (“The identical invention must be shown in as complete detail as is contained in the . . . claim”). Although it *might* be possible to bundle the silicon quantum fine wires taught by the Westwater patent, that reference does not disclose how such bundling might be performed, and indeed how such bundling might be performed in such a manner as to produce a stem shaped nanofiber. As such, the Westwater patent does not enable, and by extension, does not anticipate, claim 1 of the present application. *Elan Pharms., Inc. v. Mayo Foundation*, 346 F.3d 1051, 1054-55 (Fed. Cir. 2003) (anticipation requires enablement, whereby the reference “must teach one of ordinary skill in the art to make or carry out the claimed invention without undue experimentation”); *Helifix Ltd. v. Blok-Lok, Ltd.*, 208 F.3d 1339 (Fed. Cir. 2000) (a prior art reference that does not enable a person of ordinary skill in the art to practice the claimed invention does not anticipate the patent claims); *Akzo N.V. v. United States Int’l Trade Comm’n*, 808 F.2d 1471, 1480 (Fed. Cir. 1986) (anticipation requires that the reference publicly discloses all elements of the claimed invention and enables its practice).

The Office also contends that Figures 1C and 3 of the Westwater patent “are similar to [Appellant’s] Figure 1C”. *See* 8/16/2006 Office Action at page 3. However, in contrast to Figures 1C and 3 of the Westwater patent, which, as discussed *supra*, are explicitly said to depict a multiplicity of nanowires, Appellant’s Figure 1C shows numerous vertically-oriented nanofibers. *See* specification at page 5, lines 4-6 & lines 12-15. While it is true that Figures 1C and 3 of the Westwater patent depict numerous vertically oriented elongate structures, every explication of these figures in the Westwater patent specifically provides that the individual structures depicted therein are each nanowires, *not* nanofibers. Thus, the “similarity” alleged by the Office between Figures 1C and 3 of the Westwater patent on the one hand, and Appellant’s Figure 1C on the other is only true with regard to visual

appearance, not substantive character. The Westwater patent does not disclose silicon nanofibers having a stem shaped cross-sectional configuration. Therefore, the cited reference cannot be said to anticipate claim 1 under 35 U.S.C. § 102(b). *Verdegaal Bros. v. Union Oil Co. of Calif.*, 814 F.2d 628, 631 (Fed. Cir. 1987) (“A claim is anticipated only if each and every element in the claims is found, either expressly or inherently described, in a single prior art reference”). Claim 2, which includes all of the limitations of claim 1, is likewise not anticipated by the Westwater patent.

Claims 3, 4, and 6-9

Claim 3 is not invalid under 35 U.S.C. § 102(b) over the Westwater patent because the cited reference does not disclose a nanofiber of which a portion forms a joint having a diameter less than that of the portion of the nanofiber preceding the joint and less than that of the portion of the nanofiber following the joint.

The Office has argued that the Westwater patent discloses nanowires with a joint portion having a diameter less than that of the portions of the nanowire preceding and following the joint. *See* 8/16/2006 Office Action at page 3. It is not the case, and Appellant has never conceded, that the Westwater patent discloses nanowires with a joint portion having a diameter less than that of the portions of the nanowire preceding and following the joint. The Office cites Figure 3 of the Westwater patent as teaching such jointed nanowires. *See id.* It is apparently the view of the Office that the nanowires depicted in Figure 3, which feature an elongated middle portion having a flared cap-like structure at the extreme upper end and a flared base at the extreme lower end, possess a “joint” in the sense that the aforementioned elongated middle portion has a smaller diameter than both the flared cap-like structure and the flared base. However, as discussed *infra*, the elongated middle portion does not comprise a “joint” as that claim element is defined in the current specification. *See Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 1458 (Fed. Cir. 1984) (in deciding the issue of anticipation, the trier of fact must identify the elements of the claims, determine their meaning in light of the specification and prosecution history, and identify corresponding elements disclosed in the allegedly anticipating reference).

First, a “joint” of the current invention is the result of when a heat releasing process is interposed between two separate heating processes. *See* specification at page 10, lines 26-29. Each heating process results in vertical growth of the silicon nanofiber. *See* specification at page 10, lines 11-14. Thus, a “joint” of the current application is interposed between vertical, elongate portions of the nanofiber. A “joint” as defined in the current application is not itself the main elongate body of the nanofiber, interposed between small upper and lower flared flanges, as featured on the nanowires in Figure 3 of the Westwater patent.

Second, a “joint” as defined in the current application is “small”, *i.e.*, relative to the total size of the nanofiber. *See* specification at page 10, lines 28-29. In contrast, the elongated middle portion of the respective nanowires disclosed by the Westwater patent essentially comprises the entirety of each of the structures depicted in Figure 3 of that reference. Thus, the elongated middle portion of the nanowires shown in Figure 3 the Westwater patent is not a “joint” as defined in the present application.

Third, the flared caps and the flared bases of the structures formed in accordance with the processes of the Westwater patent is not considered by the drafters of the Westwater patent to be part of the “quantum fine wire” (*i.e.*, of the nanowire), and one skilled in the art would not view it as such. The Westwater patent specifies that “the diameter of each quantum fine wire 13 is dependent on the diameter of each molten alloy drop”. *See* Westwater patent at col. 3, lines 14-16. If the flared caps and flared bases of the structures depicted in Figure 3 of the Westwater patent were considered part of the nanowire structure, then the preceding quotation from col. 3, lines 14-16 would be false, as the nanowire would comprise portions of varying diameters (because the flared cap, flared base, and elongated middle portion of the structures depicted in Figure 3 each appear to possess different diameters), which would belie the notion expressed at col. 3, lines 14-16 that the silicon nanowire has a single diameter that corresponds to the diameter of the molten alloy drop. Thus, the flared cap and the flared base cannot be a “portions of the nano[wire] preceding and following the joint”, since they are not part of the nanowire as taught by the Westwater patent.

Fourth, the elongated middle portion of the structures depicted in Figure 3 of the Westwater patent cannot be “joints” as defined by the present application because they are not optional portions that are introduced via deliberate intervention in the nanostructure-

forming process.¹ As discussed *supra*, a joint of the current invention is the result of when a heat releasing process is interposed between two separate heating processes. *See* specification at page 10, lines 26-29. Indeed, the essential nature of the “joints” of the current invention (*i.e.*, the fact that they are produced by a heat releasing process that could be performed as many times as desired) would not be inconsistent with including more than one noncontiguous “joint” in a single nanofiber of the current invention. In contrast, the elongated middle portion of the structures depicted in Figure 3 of the Westwater patent comprise the entire nanowire, as discussed *supra*, and cannot be excluded from the nanowire during the process of manufacture without depriving the process of what is essentially the nanostructure itself, and cannot be duplicated within a single nanowire to provide numerous noncontiguous elongate middle portions. Thus, the elongate middle portion of the structures disclosed by the Westwater patent cannot be considered “joints”.

For at least these reasons, the Westwater patent cannot be said to disclose a “joint” as required by claim 3 and defined by the instant specification.

Furthermore, even if the Westwater patent could hypothetically be said to disclose a true “joint”, such joints would only be disclosed in the context of nanowires, not nanofibers, as required by rejected claim 3. Although the Office has argued that a joint in a nanowire would meet the limitations of a joint in a nanofiber because bundled nanowires with joints would form a nanofiber that “will take on the properties of the nanowires [of which] the nanofiber is composed” (*see* 12/01/2006 Advisory Action at page 2), the Office has provided no support for this argument, *e.g.*, in the form of technical data or using an explanatory art reference, and as such the Office’s argument amounts to mere conjecture as to what could possibly occur when the nanowires disclosed by the Westwater patent are bundled, or even whether such bundling would be technically feasible in the first instance. *See Trintec Indus., Inc. v. Top-U.S.A. Corp.*, 295 F.3d 1292, 1295 (Fed. Cir. 2002) (it is not sufficient for anticipation if a material element or limitation is “merely probably or possibly present” in the

¹ Although claim 3 does require the presence of a joint in the claimed nanofiber, the present argument goes to the question of what structures can be considered to be “joints” as defined by the present application. *See Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 1458 (Fed. Cir. 1984) (in deciding the issue of anticipation, the trier of fact must identify the elements of the claims, determine their meaning in light of the specification and prosecution history, and identify corresponding elements disclosed in the allegedly anticipating reference).

prior art); *W.L. Gore v. Garlock, Inc.*, 721 F.2d 1540, 1554 (Fed. Cir. 1983) (anticipation “cannot be predicated on mere conjecture respecting the characteristics of products that might result from the practice of processes disclosed in references”).

Accordingly, the Office’s argument that claim 3 is invalid under 35 U.S.C. § 102(b) over the Westwater patent falls far short of what is required under the law. Claims 4 and 6-9, which include all of the limitations of claim 3, are likewise not anticipated by the Westwater patent.

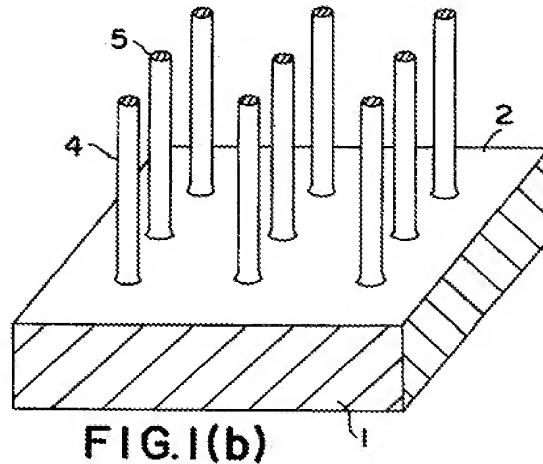
Rejection of Claims 1-2 Under 35 U.S.C. § 102(b) Over the Okajima Patent

Claim 1 is not invalid under 35 U.S.C. § 102(b) over the Okajima patent because the cited reference does not disclose a nanofiber comprising numerous bundled nanowires and having a stem shaped cross-sectional configuration. The Okajima patent discloses methods for the preparation of “fine structures” comprising needle-like silicon crystals. *See, e.g.*, Okajima patent at col. 3, lines 21-23; col. 4, lines 53-57; col 5, lines 33-39 & lines 62-65. The Office contends that the Okajima patent also “teaches silicon nanowires bundled in the same direction with a space between nanowires, such that a nanofiber has a stem shaped cross-sectional configuration” and, to this end, directs the Appellant to “note Figure 1(b)”, which the Office asserts is “similar to [Appellant’s] Figure 1C”. *See* 8/16/2006 Office Action at page 4. The Office’s argument represents a failure to appreciate the nature of the structures respectively depicted in Figure 1(b) of the Okajima patent and in Figure 1c of the present application. Figure 1(b) of the Okajima patent depicts a population of vertically oriented structures, individually labeled with reference numeral 4, that are said to be “fine structures of needle like crystals” / “needle like silicon crystals” (*see* Okajima patent at col. 2, lines 63-65; col. 4, lines 51-55; col. 5, lines 33-39), which, according to the Office, “reads on [appellant’s] nanowires” (*see* 8/16/2006 Office Action at page 4). Although Figure 1c of the present application also depicts a population of vertically oriented structures, the individual structures, labeled with reference numeral 4, are nanofibers, not nanowires. *See* specification at page 5, lines 3-6 & lines 12-15.

For clarification purposes, reproduced below are Figure 1(b) of the Okajima patent, wherein reference numeral 4 corresponds to individual “fine structures of needle like crystals”, *i.e.*, nanowire-like structures (*see* Okajima patent at col. 2, lines 63-65), and Figure

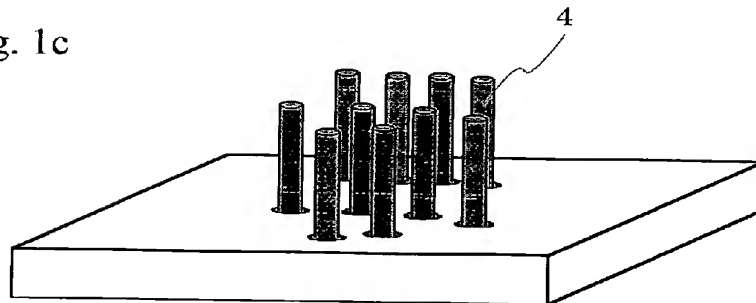
1c of the present application, in which reference numeral 4 corresponds to individual nanofibers (*see* specification at page 5 lines 3-6 & lines 12-15):

Okajima patent:



Present application:

Fig. 1c



Therefore, citation to Figure 1(b) of the Okajima patent does nothing to advance the Office's contention that the Okajima patent discloses stem shaped nanofibers. The only similarity between Figure 1(b) of the Okajima patent and Figure 1c of the present application is that both share the visual appearance of having respective populations of vertical structures; the resemblance between the two figures ends there, however, and mere visual similarity does not suffice for anticipation. *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236 (Fed. Cir. 1989) ("The identical invention must be shown in as complete detail as is contained in the . . . claim"); *Lindemann Maschinenfabrik GMBH v. American Hoist & Derrick Co.*, 730 F.2d 1452, 1458 (Fed. Cir. 1984) (in deciding the issue of anticipation, the

trier of fact must identify the elements of the claims, determine their meaning in light of the specification and prosecution history, and identify corresponding elements disclosed in the allegedly anticipating reference).

Additionally, even were Appellant hypothetically to concede that the individual structures depicted in Figure 1(b) of the Okajima patent were stem-shaped, then the Office would only have demonstrated that the Okajima patent discloses stem-shaped nanowires, not stem-shaped nanofibers as required by claim 1 of the instant application. Furthermore, the Office has presented no evidence that the Okajima patent discloses the bundling of the depicted “fine structures of needle like crystals”, let alone whether, if such bundling were disclosed, the resulting bundle would form a nanofiber having a stem shaped cross-sectional configuration. To assert that any conglomeration of the “fine structures of needle like crystals” would result in a stem shaped nanofiber would represent impermissibly far-reaching conjecture. *Trintec Indus., Inc. v. Top-U.S.A. Corp.*, 295 F.3d 1292, 1295 (Fed. Cir. 2002) (it is not sufficient for anticipation if a material element or limitation is “merely probably or possibly present” in the prior art); *W.L. Gore v. Garlock, Inc.*, 721 F.2d 1540, 1554 (Fed. Cir. 1983) (anticipation “cannot be predicated on mere conjecture respecting the characteristics of products that might result from the practice of processes disclosed in references”).

Accordingly, the Okajima patent fails expressly or inherently to disclose nanofibers having stem shaped cross-sectional configurations as required, and for at least this reason, claim 1 is not anticipated under 35 U.S.C. § 102(b). *Verdegaal Bros. v. Union Oil Co. of Calif.*, 814 F.2d 628, 631 (Fed. Cir. 1987) (“A claim is anticipated only if each and every element in the claims is found, either expressly or inherently described, in a single prior art reference”). Claim 2, which includes all of the limitations of claim 1, is likewise not anticipated by the Okajima patent.

Conclusions

Appellants request that this patent application be remanded to the Patent Office with an instruction to withdraw the rejections of the claims under 35 U.S.C. § 112, first paragraph, and 35 U.S.C. § 102(b), and allow the appealed claims.

Respectfully submitted,

Date: August 15, 2007

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CLAIMS APPENDIX

The following claims are involved in the present appeal:

1. A nanofiber comprised of numerous nanowires, comprising silicon which is oriented and is bundled in a same direction as said nanowires, provided with a space between nanowires, such that the nanofiber has a stem shaped cross-sectional configuration.
2. The nanofiber of claim 2, having a joint portion shaped like a constriction where a diameter is smaller.
3. A nanofiber, comprising:
a plurality of silicon nanowires oriented along a single axis, a portion of the nanofiber forming a joint aligned with the axis, the joint having a diameter less than that of the portions of the nanofiber preceding and following the joint.
4. The nanofiber of claim 3, wherein the nanowires are produced by heating silicon microcrystal grains placed on the surface of a silicon substrate.
5. The nanofiber of claim 4, wherein the diameter of the nanofiber is approximately equivalent to the size of the microcrystal grain.
6. The nanofiber of claim 3, wherein the nanowires are produced by heating silicon microcrystal grains placed on the surface of a silicon substrate, the grains and substrate having been coated by a layer of vapor deposited gold.
7. The nanofiber of claim 4 or 6, wherein the heating takes place in a vacuum.
8. The nanofiber of claim 7, wherein the atmosphere in the vacuum is initially air.
9. The nanofiber of claim 4 or 6, wherein the joint is formed by interrupting the heating to allow a dissipating period, followed by further heating.

EVIDENCE APPENDIX

No additional evidence is submitted in the Evidence Appendix.

RELATED PROCEEDINGS APPENDIX

No related appeals or interferences are pending.